

CLAIMS

1. A fuel reforming device which generates reformat gas comprising hydrogen by reforming a mixture of a hydrocarbon fuel and air, comprising:

a fuel mixing chamber (24);

a fuel injector (1) which injects the hydrocarbon fuel into the fuel mixing chamber (24);

a first air distribution valve (10) which supplies air to the fuel mixing chamber (24) and generates an air-fuel mixture;

a second air distribution valve (11) which further supplies air to the air-fuel mixture in the fuel mixing chamber (24); and

a reformer (5) comprising a reforming catalyst which generates reformat gas by causing the air-fuel mixture supplied from the fuel mixing chamber (34) to undergo reforming reaction, and an oxidation catalyst which causes the air-fuel mixture to undergo a catalytic combustion.

2. The fuel reforming device as defined in Claim 1, wherein the fuel reforming device further comprises a heater (4) which heats the fuel-air mixture, and a controller (30) functioning to control the heater (4) to heat the fuel-air mixture when the fuel reforming device starts operation (S1), and control an air supply amount of the first air distribution valve (10) to the fuel mixing chamber (24) to maintain an excess air factor of the air-fuel mixture in a predetermined lean state (S4).

3. The fuel reforming device as defined in Claim 2, wherein the fuel reforming device further comprises a sensor (32) which detects a temperature of the reformer (5), and the controller (30) further functions to determine whether or not the temperature of the reformer (5) is ascending in a state where the air-fuel mixture heated by the heater (4) is supplied to the reformer (5) (S7), and when the temperature of the reformer (5) is ascending, control the heater (4) to stop heating the air-fuel mixture (S9)

4. The fuel reforming device as defined in Claim 3, wherein the controller (30) further functions to determine whether or not the temperature of the reformer (5) is less than a predetermined temperature (S6), to increase a fuel injection amount of the fuel injector (1) with a preset increment (S4), to increase the air supply amount with a preset increment (S4), to determine whether or not an ascending rate of the temperature of the reformer (5) exceeds a predetermined rate in a state where the temperature of the reformer (5) is less than the predetermined temperature (S10), and when the ascending rate exceeds the predetermined rate, and to decrease the increment of the fuel injection amount and the increment of the air supply amount (S12).

5. The fuel reforming device as defined in Claim 4, wherein the controller (30) further functions, when the temperature of the reformer (5) is not less than the predetermined temperature, to decrease the air supply amount of the first air distribution valve (10) until the air excess factor of the air-fuel mixture

reaches a predetermined rich state (S107), increase the air supply amount of the second air distribution valve (11) to the fuel mixing chamber (24) so as to compensate for the decrease of the air supply amount of the first air distribution valve (10) (S106), and then close the second air distribution valve (11) (S16).

6. The fuel reforming device as defined in Claim 1, wherein the fuel reforming device further comprises an air supply mechanism (9) which supplies air to the first air distribution valve (10) and the second air distribution valve (11), and a heat exchanger (6) which heats the air between the air supply mechanism (9) and the first air distribution valve (10) by performing heat exchange between the air and a gas discharged from the reformer (5).

7. The fuel reforming device as defined in any one of Claim 1 through Claim 6, wherein the fuel reforming device further comprises an air supply mechanism (9) which supplies air to the first air distribution valve (10), and a carbon monoxide removal device (8) which removes carbon monoxide from the reformat gas by a catalytic reaction using air, the first air distribution valve (10) is configured to bifurcate the air supplied from the air supply mechanism (9) to the fuel mixing chamber (24) and the second air distribution valve (11), and the second air distribution valve (11) is configured to bifurcate air supplied from the first air distribution valve (10) to the fuel mixing chamber (24) and to the carbon monoxide removal device (8).

8. The fuel reforming device as defined in any one of Claim 1 through Claim 6,

wherein the fuel reforming device is used together with a fuel cell stack (14) comprising an anode (14A) and a cathode (14B), and generating power by an electrochemical reaction between hydrogen in the reformat gas supplied to the anode (14A) and oxygen supplied to the cathode (14B), the fuel reforming device comprises an air supply mechanism (9) which supplies air to the first air distribution valve (10), the first air distribution valve (10) is configured to bifurcate the air supplied from the air supply mechanism (9) to the fuel mixing chamber (24) and the second air distribution valve (11), and the second air distribution valve (11) is configured to bifurcate the air supplied from the first air distribution valve (10) to the fuel mixing chamber (24) and the anode (14A).

9. The fuel reforming device as defined in any one of Claim 1 through Claim 6, wherein the fuel reforming device is used together with a fuel cell stack (14), comprising an anode (14A) and a cathode (14B), and generating power by the electrochemical reaction between hydrogen in the reformat gas supplied to the anode (14A) and oxygen supplied to the cathode (14B), and a combustor (16) which burns an anode effluent discharged from the anode (14A), the fuel reforming device comprises an air supply mechanism (9) which supplies air to the first air distribution valve (10), the first air distribution valve (10) is configured to bifurcate the air supplied from the air supply mechanism (9) to the fuel mixing chamber (24) and the second air distribution valve (11), and the second air distribution valve (11) is configured to bifurcate the air supplied from the first air distribution valve (10) to the fuel mixing chamber (24) and

the combustor (16).

10. The fuel reforming device as defined in any one of Claim 1 through Claim 6, wherein the fuel reforming device is used together with a fuel cell stack (14) which generates electric power according to a power generation load using hydrogen in the reformat gas supplied by the fuel reforming device, and the fuel reforming device further comprises a heater (4) which heats the air-fuel mixture, a sensor (34) which detects the power generation load, and a controller (30) functioning to calculate an increase amount of hydrocarbon fuel corresponding to an increase amount of the power generation load (S21, S22), to calculate a latent heat amount for vaporizing the increase amount of hydrocarbon fuel (S23), and to control the heater (4) to heat the air-fuel mixture for compensating the latent heat amount (S24).

11. The fuel reforming device as defined in any one of Claim 1 through Claim 6, wherein the fuel reforming device is used together with a fuel cell stack (14) which generates electric power according to a power generation load using hydrogen in the reformat gas supplied by the fuel reforming device, and the fuel reforming device further comprises an air supply mechanism (9) which supplies air to the first air distribution valve (10), a sensor (34) which detects the power generation load, and a controller (30) functioning to calculate a first increase amount of hydrocarbon fuel corresponding to an increase amount of the power generation load (S21, S22), to calculate a latent heat amount for vaporizing the first increase amount of hydrocarbon fuel (S23), to calculate a

second increase amount of hydrocarbon fuel for compensating the latent heat amount by a catalytic combustion of the second increase amount of hydrocarbon fuel, to increase a fuel injection amount of the fuel injector (1) according to the sum of the first increase amount of hydrocarbon fuel and the second increase amount of hydrocarbon fuel (S31), and to control the air supply mechanism (9) and the first air distribution valve (10) to increase an air supply amount to the fuel mixing chamber (24) according to an increased fuel injection amount by the fuel injector (1) (S27, S31).

12. The fuel reforming device as defined in Claim 11, wherein the fuel reforming device further comprises a carbon monoxide removal device (8) which removes carbon monoxide from the reformat gas by a catalytic reaction using air, the first air distribution valve (10) is configured to bifurcate the air supplied from the air supply mechanism (9) to the fuel mixing chamber (24) and the second air distribution valve (11), the second air distribution valve (11) is configured to bifurcate air supplied from the first distribution valve (10) to the fuel mixing chamber (24) and the carbon monoxide removal device (8), and the controller (30) further functions to estimate a temperature ascending amount of the reformer from the increased fuel injection amount by the fuel injector (1) and an increased air supply amount to the fuel mixing chamber (24) (S28), to calculate a generated amount of carbon monoxide in the reformer (5) corresponding to the increased fuel injection amount and the increased air supply amount (S29), and to control the air supply mechanism (9) and the second air distribution valve (11) to supply a required amount of air to the

carbon monoxide removal device (8) which the carbon monoxide removal device (8) requires for removing carbon monoxide of the generated amount from the reformat gas.

13. The fuel reforming device as defined in any one of Claim 1 through Claim 6, wherein the fuel reforming device further comprises a switch (35) which commands the fuel reforming device to start and stop operation, an air supply mechanism (9) which supplies air to the first air distribution valve (10), and a controller (30) functioning, when the switch (35) has commanded the reforming device to stop operation, to stop injection of hydrocarbon fuel by the fuel injector (1) (S41), and to maximize an air supply amount of the air supply mechanism (9) (S42).

14. The fuel reforming device as defined in any one of Claim 1 through Claim 6, wherein the fuel reforming device further comprises a switch (35) which commands the fuel reforming device to start and stop operation, an air supply mechanism (9) which supplies air to the first air distribution valve (10), a heater (4) which heats the air-fuel mixture, and a controller (30) functioning, when the switch (35) has commanded the fuel reforming device to stop operation, to stop injection of hydrocarbon fuel by the fuel injector (1) (S41), to maximize an air supply amount of the air supply mechanism (9), and to activate the heater (43) to heat the air-fuel mixture (S43).

15. The fuel reforming device as defined in any one of Claim 1 through Claim

6, wherein the fuel reforming device further comprises an air supply mechanism (9) which supplies air to the first air distribution valve (10), a heat exchanger (6) which warms an air supplied by the air supply mechanism (9) to the first air distribution valve (10) by heat exchange with the reformat gas, and a bypass passage (23) which connects the air supply mechanism (9) with the first air distribution valve (10) bypassing the heat exchanger (6).